CHARACTERISTICS OF LIQUEFIED PETROLEUM GAS (LPG) RELATED BURN INJURIES IN HASAN SADIKIN BANDUNG GENERAL HOSPITAL

CARACTÉRISTIQUES DES BRÛLÉS PAR GAZ DE PÉTROLE LIQUÉFIÉ (GPL) ADMIS À L'HÔPITAL GÉNÉRAL HASAN SADIKIN DE BANDUNG

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SUMMARY. The number of liquefied petroleum gas (LPG) related burn injuries has increased over recent years in Indonesia, since the conversion of kerosene to LPG in 2007 (government policy). Based on studies in India and China, LPG-related burn injuries have become a serious public health issue. A 5-year retrospective study was conducted from medical records of patients with LPG-related burn injuries. The data included age, gender, place, occupation, LPG tank size, mechanism, burn classification, burn site and concurrent injury. A total of 169 patients with LPG-related burn were admitted. The yearly incidence was in the range of 24-46% of all burn injury cases. They mostly occurred in males (66.2%) aged 36-55 years (43.1%). The most common place was the home (83.4%) and the most common occupation was merchant (32%). LPG leakage (94.7%) was the main cause of burn, followed by LPG explosion (5.3%). A 3-kilogram LPG tank (96.4%) was the most common cause. Patient burn classification was mostly major burns (62.1%), with the most common site being the head and neck (73%), and concurrent with inhalational injury (16%). Our study showed that the increasing number of LPG-related burn injuries is alarming. The majority of the patients were males in the productive age and they suffered major burns. Some of them suffered inhalation injury that increases the risk of mortality. Since LPG leakage was the main cause and the most common place was the home, there must be regulation with government related prevention strategies.

Keywords: LPG, burn injury, characteristic

RÉSUMÉ. *Le nombre de brûlures par GPL a augmenté ces dernières années en Indonésie, suivant la loi sur la conversion kérosène/GPL de 2007. Les études indiennes et chinoises en font un problème de santé publique. Nous avons revu les dossiers des 169 patients admis pour de telles brûlures pendant 5 ans. Les données étudiées comprenaient l'âge, le sexe, le lieu, l'activité, la taille du réservoir de GPL, le mécanisme, la surface, la profondeur, les zones brûlées et les lésions associées. Ces brûlures représentaient 22 à 46% de l'ensemble. Elles touchaient préférentiellement des hommes (66,2%) de 36 à 55 ans (43,1%). Bien que survenant le plus souvent au domicile (83,4%), elles étaient liées à des activités commerciales dans 32% des cas. La fuite de GPL était la cause très largement majoritaire (94,7%), les explosions ne représentant que 5,3% des mécanismes, la bonbonne de 3kg étant impliquée dans 96,4% des accidents. Les brûlures étaient considérées comme graves dans 62,1% des cas ; la zone cervico- faciale était atteinte 3 fois sur 4 (73%). Une inhalation était observée dans 16% des cas. Notre étude montre l'augmentation préoccupante des brûlures graves par GPL, survenant chez des hommes actifs, certains d'entre eux souffrant en plus d'une inhalation, qui accroît le risque létal. La fuite de GPL en étant l'origine prédominante, une législation de prévention primaire doit être mise en place.*

Mots-clés *: gaz de pétrole liquéfié, brûlures, caractéristiques*

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Introduction

Burn injury is defined as damage to the skin and soft tissues caused by heat or cold trauma. Burns may be caused by fire, hot water, electricity, chemicals, radiation or cold temperature.[1] Burn injury is a significant health problem, with some 265,000 deaths globally attributed to burn injuries or burn-associated complications every year. In addition, burn injuries may also cause irreversible cosmetic and functional damage, disability and uncertainty for the patients.[2] According to the World Health Organization, nearly 90% of all burn cases are found in middle-to-lower income countries, where there are insufficient infrastructures and regulations to prevent burn injuries. Studies in Bangladesh and Ethiopia showed that the vast majority of these injuries occurred at home, the most common causes being hot water, fire and cooking stove explosions.[3] At Dr. Hasan Sadikin Hospital (RSHS) Bandung, there were 164 burn injury cases (study of bacterial pathogens and antibiotic sensitivity) in 2012-2015, of whom 71 patients (43.3%) did not survive.[4] It is important to note that infection and septic shock also contribute to a large number of deaths in burn patients.[5]

Liquefied petroleum gas (LPG) is a widely used domestic fuel in developing countries. It is a highly flammable and volatile mixture of hydrocarbon gases produced through the refinement of petroleum. Previously, kerosene was one of the most commonly used domestic fuels in Indonesia. In 2007, the Indonesian government introduced a policy to convert the remaining populace from using kerosene to the more energy-efficient and environmentally friendly LPG.[6] This policy caused an increase in LPG utilization in the community. Nevertheless, a lack of regulation and public knowledge inadvertently resulted in a number of LPG-associated accidents, most of which caused multiple burn injuries. Currently, there is a lack of scientific literature concerning the nature of LPG-associated burn injuries, especially in Indonesia. Therefore, this study was conducted to elucidate the characteristics of LPG-related burn injuries.

Materials and methods

This is a 5-year retrospective descriptive study. Data were obtained from medical records of burn injury patients in RSHS, Bandung, from January 1st, 2014 until December 31st, 2018. All eligible medical records were included in the study. Patient demographics include the patient's age, gender, place of accident and occupation. Wound characteristics include wound size, location, mechanism, severity and concurrent injuries.

Results

A total of 509 burn injury cases were found during the 2014-2018 period. Over the 5-year period there were 169 LPG-related burn injury cases, amounting to 33% of total burn cases. The demographic characteristics of LPG-related burn injury patients are shown in *Table I*. The highest total cases were found in 2018 with 173 cases (32% of incidence) and the highest incidence was 46% in 2017. It was apparent that there was an increasing number of burn cases each year, both LPG-related and overall (*Fig. 1*). Patient age was classified into four groups of 0-17 years old, 18-35 years old, 36-55 years old, and 56 years old and over. Nearly half of

Table I - Demographic characteristics of liquefied petroleum gas (LPG) related burn injuries

Year	Burn cases	LPG-related	Incidence (%)
2014	51	15	29%
2015	73	21	29%
2016	94	23	24%
2017	118	54	46%
2018	173	56	32%
Total	509	169	33%
Age (LPG only)	**n**	**%**	
0-17 years	23	13.6%	
18-35 years	42	24.9%	
36-55 years	73	43.2%	
> 56 years	31	18.3%	
Gender (LPG only)	**n**	**%**	
Male	112	66.2%	
Female	57	33.8%	
Occupation	**n**	**%**	
Cook	8	4.7%	
Merchant	54	32.0%	
Homemaker	43	25.4%	
Employee	35	20.7%	
Others	29	17.2%	
Place	**n**	**%**	
Home	141	83.4%	
Workplace	18	10.7%	
Restaurant	3	1.8%	
Others	7	4.1%	

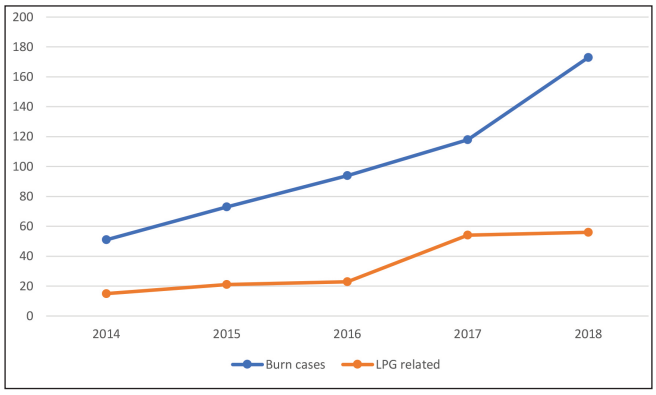

Fig. 1 - Liquefied petroleum gas (LPG) related burn injuries compared with total burn injury cases

all cases (43.2%) occurred in the 36-55 year-old adult group (*Fig. 2*), and approximately two-thirds (66.2%) of the cases were male (*Fig. 3*). Males were predominant in every age group.

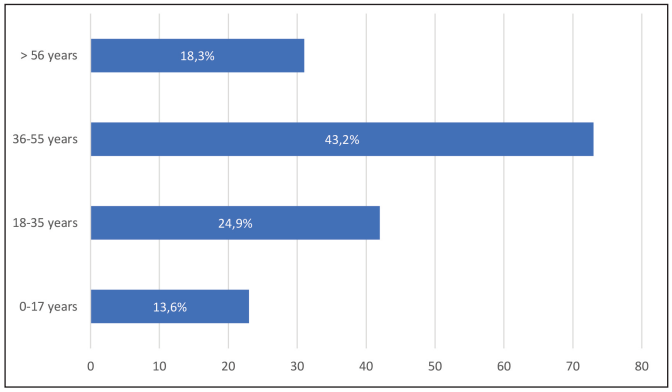

Fig. 2 - Age distribution of liquefied petroleum gas (LPG) related burn injuries

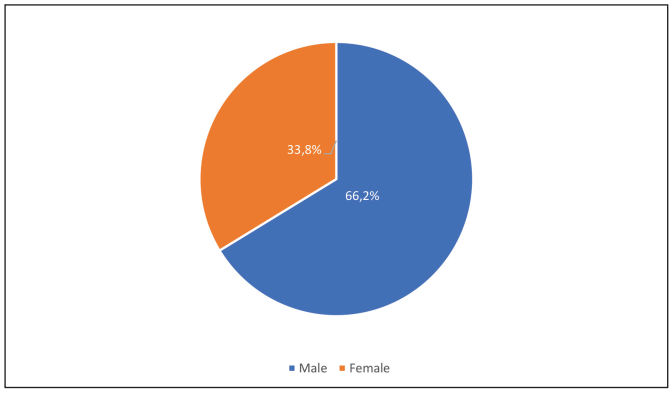

Fig. 3 - Gender distribution of liquefied petroleum gas (LPG) related burn injuries

The vast majority of LPG burn cases in our study occurred in the residential setting (83.4%). A small number of cases (10.7%) occurred in the workplace, such as in shops and on merchant stalls. Only 1.8% of cases occurred in restaurants (*Fig. 4*). Approximately half of the patients were either merchants (32.0%) or homemakers (25.4%). Nearly all of the LPG-related burn injury cases originated from the ubiquitous residential 3kg LPG tank (96.4%), and the rest from the less common, commercial 5kg and 12kg tank. There were 160 cases caused mostly by LPG tank leakage, 94.7% of all cases caused, while the rest were caused by tank explosion.

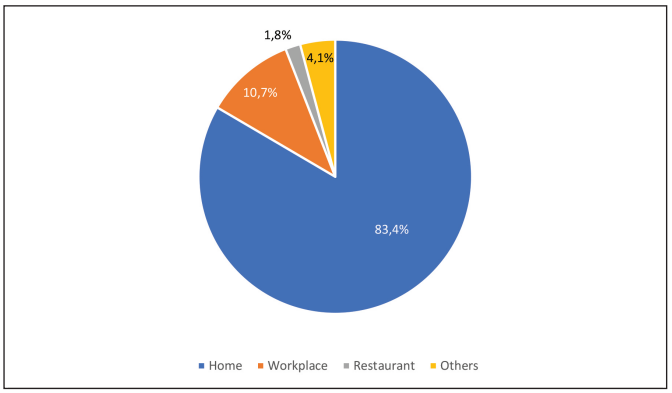

Fig. 4 - Place of accident of liquefied petroleum gas (LPG) related burn injuries

Table II - Wound characteristics of liquefied petroleum gas (LPG) related burn injuries

Severity	**n**	**%**
Mild	29	17.2%
Moderate	35	20.7%
Severe	105	62.1%
Site of injury	**n**	**%**
Head and neck	123	73%
Anterior trunk	108	64%
Posterior trunk	57	34%
Upper limb	95	56%
Lower limb	73	43%
Genitalia	39	23%
Concurrent injuries	**n**	**%**
Inhalational	27	16.0%
Shock	2	1.2%
Multiple injuries	0	0.0%
None	140	82.8%
Other injuries	0	0.0%

Based on the wound characteristics (*Table II*), nearly two-thirds (62.1%) of cases were classified as major burns, 20.7% were moderate burns, and 17.2% were mild burns (*Fig. 5*). These burns, particularly the severe ones, often affected multiple body regions, with the head and neck region the most commonly affected (73%), followed by the anterior trunk (64%), and the upper limbs (56%) (*Fig. 6*). Although most patients were not affected by con-

current injuries, there were 16.0% cases with inhalational injuries, and 1.2% cases with shock (both hypovolemic and septic).

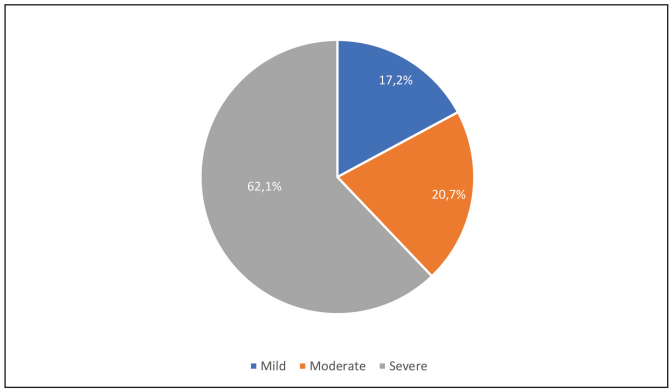

Fig. 5 - Burn severity of liquefied petroleum gas (LPG) related burn injuries

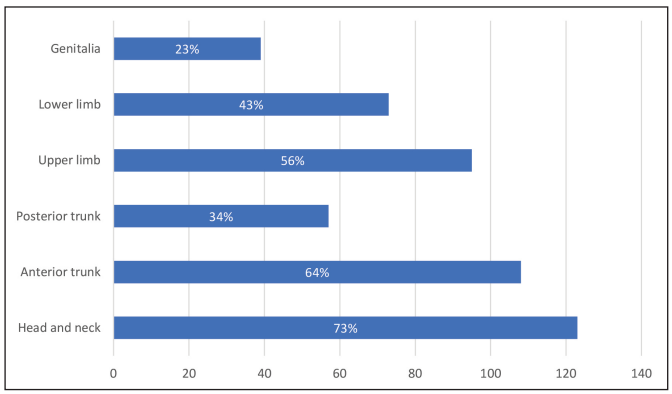

Fig. 6 - Body region of liquefied petroleum gas (LPG) related burn injuries

Discussion

LPG is a product of petroleum refinement, consisting of a mix of hydrocarbon compounds pressurized into liquid form. It is a volatile compound and is gaseous in free air. LPG is a widely used domestic fuel in developing countries, most often used for cooking fuel for stoves. In 2007, the Indonesian government introduced a conversion policy to transition from the widespread use of kerosene to LPG. This policy was applied to improve household cooking fuel, provide cleaner energy access and reduce the government's huge subsidy.[6] Although fires are still the leading cause of burn injuries in Indonesia,[7] this conversion policy has caused a sharp increase in the use of domestic LPG, and along with it, an increase in LPG-associated burn injuries.

Similarly, in India, a study reported an increase in the incidence of LPG-associated burn injuries from 10.7% during 2001-2007 to 20.2% during 2009-2010.[8] In China, the incidence of LPG-associated burn injuries increased from 10% (2011-2014) to 26.9% (2015).[9] Our study is in agreement with this previous data, with an increase in the annual incidence of both LPG-related burn injuries and the overall number of burn injuries from 2014 until 2018.

Our study showed that the majority of LPG-associated burn injury patients were of the productive age group (18-55 years old). This raised concerns about loss of productivity, due to a high rate of permanent and disabling complications of burn injuries such as contracture. The majority of these patients were merchants of low socioeconomic and educational status. Therefore, it is possible that the lack of awareness and knowledge of safe handling and the risks of LPG usage contributed to these accidents. Furthermore, a study stated that in a community subdistrict in Indonesia those who used LPG didn't have adequate knowledge regarding prevention or management of burns.[10]

In our study, the vast majority of cases occurred in the residential setting. This is in agreement with several studies in Bangladesh and Ethiopia, which showed that 80-90% of all burn cases occurred in the residential setting.[3] The densely populated residential area contributed to the number of multiple casualties in a single accident. In Indonesia, LPG for public use is available in 3kg, 5kg and 12kg tanks. The 3kg tanks are the most ubiquitous, and are subsidized by the government for non-commercial use by the poor. In our study, 96.4% of LPG-associated burn cases originated from these 3kg tanks. This raised the question of whether the accidents were caused purely by lack of knowledge and awareness or by the quality of the LPG tank manufacture. Nevertheless, this issue is not addressed in this study where only retrospective data is analyzed.

According to the American Burn Association, burn injuries may be classified by their severity into mild, moderate, and severe or major burns.[11,12] Nearly two-thirds of the patients in our study suffered from severe burns. A study said that 55% of severe burns in RSHS, Bandung, lead to sepsis.[13] It

is important to note that severe burns are often accompanied by concurrent injuries, such as inhalation injury, shock (both septic and hypovolemic), and multiple injuries.[7] Our study showed a relatively low occurrence of concurrent injuries, with 16% of patients presenting with inhalation injury and 1.2% presenting with shock. The upper body was the most commonly affected area in LPG-related burn injuries. This was possibly caused by the closer distance of the face, trunk and upper limbs towards the stovetop compared to the lower limbs.[9] In our study, the most commonly affected areas were the head and neck (73%), followed by the anterior trunk (64%) and the upper limbs (56%).

There are several limitations to this study. Data were collected in only a single-center, and mild burn patients who presented to the surgical outpatient clinic were not included in this study. In addition, the retrospective nature of the study means that there are important variables that are not analyzed concerning the true mechanism of LPG-related burn injuries. However, this study has reported characteristics of LPG-associated burn injuries and risk factors that have never been reported previously in Bandung Indonesia. The results of the study are also expected to provide information about the potential danger of burns caused by LPG and to propose government prevention strategies to reduce the incidence of LPG-related burn injuries.

Conclusion

Our study showed that the increasing number of LPG-related burn injuries is alarming. The majority of the patients were males in the productive age who suffered from major burns. Some of them suffered inhalation injury, which increases the risk of mortality. Since LPG leakage was the main cause and the most common place was the home, there must be regulation by the government to put in place prevention strategies.

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